HEATH
Schlumberger

DECADE RESISTANCE BOX

MODEL EU-30A

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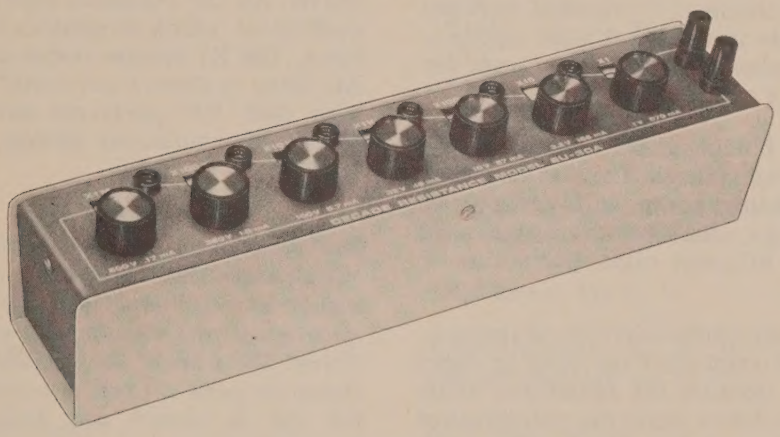
HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022
a Schlumberger company

OPERATION OF THE

DECADE RESISTANCE BOX

MODEL EU-30A



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INTRODUCTION

The Model EU-30A Decade Resistance Box is an adjustable series of resistors that will yield any resistance value from 1 Ω to 9,999,999 Ω in 1 Ω steps. As an accurate laboratory instrument, the Decade Resistance Box is a most useful and flexible variable resistance device. Resistance in ohms may be read directly at the windows of the seven twelve-position switches.

In addition, connections are provided between each decade for use in voltage divider applications. Unused decades can also be bypassed for very low resistance applications.

Universal six-way binding posts terminate each end of the decade resistances. The standard 3/4" center-spaced binding posts will accept two single banana plugs, dual banana patch cord plugs, spade lugs, alligator clips, phone tips or wire.

Nonshorting decade switches have break-before-make action. The circuit does not open or short between positions because the resistance value is never more than three times the resistance of the adjacent switch positions. The decade switch contacts are made of solid silver alloy to allow a low total resistance of approximately $1.5 \times 10^{-3}\ \Omega$ at the binding posts with all the decades set at 0. All the decade resistors are ±.1% accuracy, except those in the X1 decade which are ±1% accuracy.

NOTE: All the resistors have a low temperature coefficient which eliminates temperature problems. The X1 decade resistors are wire-wound. All other resistors are metal film. This insures less than 100 parts-per-million per-degree-centigrade resistance change.

This instrument is one of the units included in the Malmstadt-Enke EU-101A Instrumentation Laboratory. It is available as an individual unit, or it can be purchased at a special group price when included with the total EU-101A System. The units of the complete EU-101A Laboratory Station are useful not only in learning electronic concepts, but also in research and development, and control instrumentation.

SPECIFICATIONS

Range	1 Ω to 9,999,999 Ω in 1 Ω steps.
Resistors	1 watt precision, with ±0.25% accuracy, except those in the X1 decade which are ±1% accuracy. (In accoradance with Mil-R-10509.)

Maximum Voltage And Current For Each Decade.

Decade	Voltage (V)	Current (mA)
X1	1	570
X10	3.2	185
X100	10	57
X1k	32	18
X10k	100	5.7
X100k	320	1.8
X1M	500	0.17

Decade Taps	6 taps terminated in banana jacks and wired between adjacent decades.
Switch Contacts	Solid silver alloy.
Minimum DC Resistance	Approximately 50 x 10^{-3} Ω at binding posts with all decades set at 0.
Temperature Coefficient	±100 ppm/degree C.
Readout	Numbered discs on switch shafts; visible through windows above each decade.
Dimensions	2-5/8" wide x 13-3/8" long x 2-7/8" deep.
Weight	2-1/4 lbs.

OPERATION

SETTING AND READING RESISTANCE VALUES

Resistance values may be set up easily by dialing the numbers. The example below shows how to set the decade switches to 429,065 Ω. Set the X1M decade dial to 0, X100k to 4, X10 k to 2, X1k to 9, X100 to 0, X10 to 6 and X1 to 5. The resistance adds up as follows:

0 x 1 MΩ	=	0,000,000 Ω
4 x 100 kΩ	=	400,000 Ω
2 x 10 kΩ	=	20,000 Ω
9 x 1 kΩ	=	9,000 Ω
0 x 100 Ω	=	000 Ω
6 x 10 Ω	=	60 Ω
5 x 1 Ω	=	5 Ω
The total is		429,065 Ω

NOTE: When one or more of the decade windows are blank instead of 0, the Decade Resistance Box will not read the true resistance. These positions should be used only when you switch from 9 to 0 clockwise, or from 0 to 9 counter-clockwise. The resistance values for the blank positions are listed in the Resistance Chart which folds out from Page 5.

SETTING UNKNOWN RESISTANCE VALUES

To protect the Decade Resistance Box from damage, use the voltage-current notations on the Box and the Resistance Chart as a guide.

CONNECTIONS

Binding Posts

The total resistance of the Decade Resistance Box is available at the binding posts. Dial the resistance value needed and connect to these terminals. Voltage polarity is not important; therefore, either end of a power source may be connected to either binding post.

Banana Jacks

The resistance between the binding posts may be divided into parts of the total resistance. A banana jack between each decade makes it possible for you to eliminate unused switch contact resistances by tapping off the resistance value of a single decade or a group of decades. The desired resistance can then be obtained from the selected banana jacks. A look at the chart and the Schematic will assist you in obtaining the desired values.

Case Ground

Certain applications require that the case of the Decade Resistance Box be grounded and used as a shield. To do this, loosen one of the sheet metal screws on the case and fasten the ground wire under the screwhead.

CONSIDERATIONS

BREAK-BEFORE-MAKE SWITCHES

The break-before-make switches open the circuit between each consecutive position, but never allow more than three times the resistance of the adjacent switch positions. The switches short only when they are at 0.

RESISTOR POWER

The numbers under each decade switch knob represent a safe voltage and current limit for that decade. Use the voltage and current limits of the highest decade being used as a safe figure for the total resistance value dialed. If these voltage-current figures are exceeded, resistors may be damaged. For applications that need higher voltage or current, the Resistance Chart and the Schematic may assist you in determining maximums for the resistors being used.

CONNECTORS AND TEST LEADS

Resistance measurements are more accurate if all connections are secure and tight. Make direct connections where possible: otherwise, use short heavy-wire test leads to keep external resistance at a minimum.

APPLICATIONS

The Decade Resistance Box can be used as a precision variable resistance from 0 to 9,999,999 Ω in a great many applications, including Wheatstone bridge arms for precision resistance measurement and as a substitution box for circuit design. In addition to all the traditional applications of the Decade Resistance Box, the connections between decades allow use in precision voltage-divider applications. For instance, the decade attenuator shown in Figure 1 is obtained by setting all the switches at 9 and using the taps as shown. Ideally, the lowest resistance in Figure 1 should be 1000 Ω, but 999 Ω is within the tolerance of the decade resistors. However, if a lower resistance divider is made in the same way, a 1 Ω resistor can be put in series with the lower terminal to maintain precise decade attenuation.

This instrument is also particularly convenient to use as the input and/or feedback resistances in operational amplifier circuits. For example, the OA circuit of Figure 2 has a continuously and precisely adjustable gain from 0 to over 1000.

Another valuable OA application is the current-to-voltage converter in which $R_{in} = 0$ and the entire Decade Resistance Box is used for R_f. The output voltage is equal to the input current times R_f.

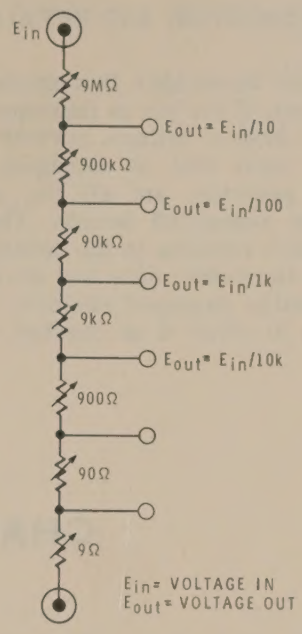


Figure 1 Attenuator Application

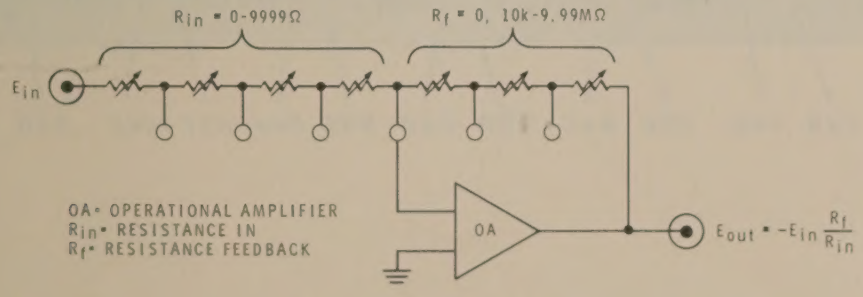


Figure 2 Operational Amplifier Gain Control Applications

DECADES		SWITCH P								
		1	→	2	→	3	→	4	→	5	→
1ST DECADE X1	RESISTANCE IN Ω	0	3	1	3	2	6	3	6	4	6
	RESISTORS USED IN Ω		1 2	1	1 2	2	1 2 3	3	1 2 3	1 3	1 2 3
2ND DECADE X10	RESISTANCE IN Ω	0	30	10	30	20	60	30	60	40	60
	RESISTORS USED IN Ω		10 20	10	10 20	20	10 20 30	30	10 20 30	10 30	10 20 30
3RD DECADE X100	RESISTANCE IN Ω	0	300	100	300	200	600	300	600	400	600
	RESISTORS USED IN Ω		100 200	100	100 200	200	100 200 300	300	100 200 300	100 300	100 200 300
4TH DECADE X1k	RESISTANCE IN Ω	0	3k	1k	3k	2k	6k	3k	6k	4k	6k
	RESISTORS USED IN Ω		1k 2k	1k	1k 2k	2k	1k 2k 3k	3k	1k 2k 3k	1k 3k	1k 2k 3k
5TH DECADE X10k	RESISTANCE IN Ω	0	30k	10k	30k	20k	60k	30k	60k	40k	60k
	RESISTORS USED IN Ω		10k 20k	10k	10k 20k	20k	10k 20k 30k	30k	10k 20k 30k	10k 30k	10k 20k 30k
6TH DECADE X100k	RESISTANCE IN Ω	0	300k	100k	300k	200k	600k	300k	600k	400k	600k
	RESISTORS USED IN Ω		100k 200k	100k	100k 200k	200k	100k 200k 300k	300k	100k 200k 300k	100k 300k	100k 200k 300k
7TH DECADE X1M	RESISTANCE IN Ω	0	3M	1M	3M	2M	6M	3M	6M	4M	6M
	RESISTORS USED IN Ω		1M 2M	1M	1M 2M	2M	1M 2M 3M	3M	1M 2M 3M	1M 3M	1M 2M 3M

The shaded areas are the resistance values between the switch positions.

CE CHART

OSITIONS

6	→	7	→	8	→	9	→	10	→	11	→	12	→
5	9	6	9	7	9	8	9	9	9	9	9	3	3
2 3	1 2 3 3	3 3	1 2 3 3	1 3 3	1 2 3 3	2 3 3	1 2 3 3	1 2 3 3	1 2 3 3	1 2 3 3	1 2 3 3	3	3
50	90	60	90	70	90	80	90	90	90	90	90	30	30
20 30	10 20 30 30	30 30	10 20 30 30	10 30 30	10 20 30 30	20 30 30	10 20 30 30	10 20 30 30	10 20 30 30	10 20 30 30	10 20 30 30	30	30
500	900	600	900	700	900	800	900	900	900	900	900	300	300
200 300	100 200 300 300	300 300	100 200 300 300	100 300 300	100 200 300 300	200 300 300	100 200 300 300	100 200 300 300	100 200 300 300	100 200 300 300	100 200 300 300	300	300
5k	9k	6k	9k	7k	9k	8k	9k	9k	9k	9k	9k	3k	3k
2k 3k	1k 2k 3k 3k	3k 3k	1k 2k 3k 3k	1k 3k 3k	1k 2k 3k 3k	2k 3k 3k	1k 2k 3k 3k	1k 2k 3k 3k	1k 2k 3k 3k	1k 2k 3k 3k	1k 2k 3k 3k	3k	3k
50k	90k	60k	90k	70k	90k	80k	90k	90k	90k	90k	90k	30k	30k
20k 30k	10k 20k 30k 30k	30k 30k	10k 20k 30k 30k	10k 30k 30k	10k 20k 30k 30k	20k 30k 30k	10k 20k 30k 30k	10k 20k 30k 30k	10k 20k 30k 30k	10k 20k 30k 30k	10k 20k 30k 30k	30k	30k
500k	900k	600k	900k	700k	900k	800k	900k	900k	900k	900k	900k	300k	300k
200k 300k	100k 200k 300k 300k	300k 300k	100k 200k 300k 300k	100k 300k 300k	100k 200k 300k 300k	200k 300k 300k	100k 200k 300k 300k	100k 200k 300k 300k	100k 200k 300k 300k	100k 200k 300k 300k	100k 200k 300k 300k	300k	300k
5M	9M	6M	9M	7M	9M	8M	9M	9M	9M	9M	9M	3M	3M
2M 3M	1M 2M 3M 3M	3M 3M	1M 2M 3M 3M	1M 3M 3M	1M 2M 3M 3M	2M 3M 3M	1M 2M 3M 3M	1M 2M 3M 3M	1M 2M 3M 3M	1M 2M 3M 3M	1M 2M 3M 3M	3M	3M

MAINTENANCE

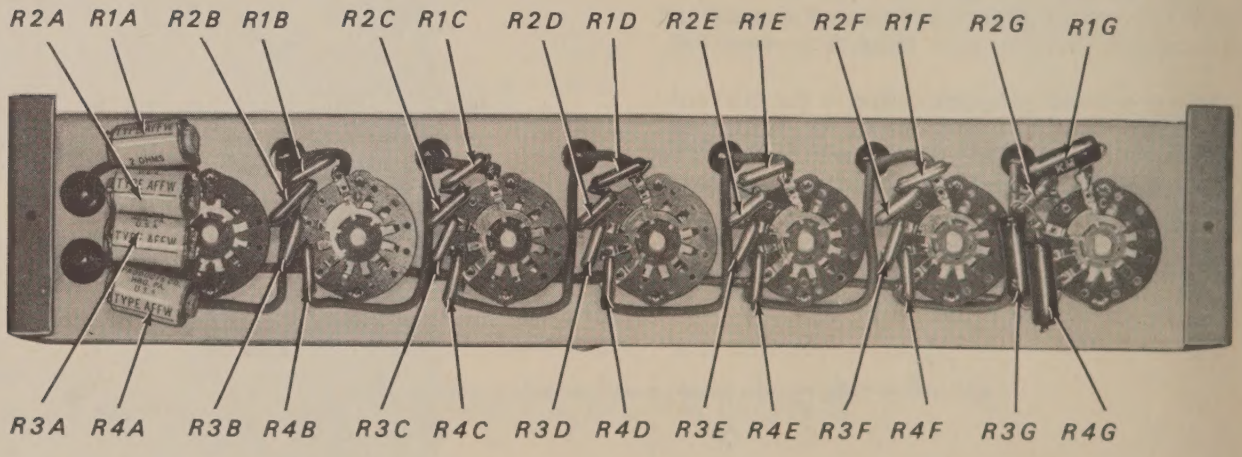
TROUBLESHOOTING AND REPAIR

The Decade Resistance Box should be virtually trouble-free. If the box is improperly used with either too high a voltage, current, or both, the resistors used will be damaged. To locate a damaged resistor, set all the decades to 0 except the suspected decade. Then check the value of each resistor in the decade and replace resistors as needed. Also test the other decades for a possible damaged resistor. Return each decade to 0 after it is checked. Refer to the Parts Pictorial and the Replacement Parts List to identify the parts.

CLEAN CONTACTS FOR PROPER RESISTANCE

If the decade switch contacts get dirty, use a readily available spray-type contact cleaner; or a cleaner can be made by mixing 2/3 ammonium hydroxide (household ammonia) with 1/3 methyl alcohol (wood alcohol). Dip a pipe cleaner into this mixture to clean the contacts. (Remember to clean both sides of each switch.)

CHASSIS PHOTOGRAPH



REPLACEMENT PARTS LIST

The numbers in parentheses relate to numbers on the Chassis Photograph and on the Schematic.

RESISTORS (1 Watt)

1.0% Resistors

PART No.	DESCRIPTION
2-61-1	1 Ω (R2A)
2-62-1	2 Ω (R1A)
2-63-1	3 Ω (R3A, R4A)

0.1% Resistors

PART No.	DESCRIPTION
2-64-1	10 Ω (R2B)
2-65-1	20 Ω (R1B)
2-66-1	30 Ω (R3B, R4B)
2-67-1	100 Ω (R2C)
2-68-1	200 Ω (R1C)
2-69-1	300 Ω (R3C, R4C)
2-70-1	1 kΩ (R2D)
2-71-1	2 kΩ (R1D)
2-72-1	3 kΩ (R3D, R4D)
2-73-1	10 kΩ (R2E)
2-74-1	20 kΩ (R1E)
2-75-1	30 kΩ (R3E, R4E)
2-76-1	100 kΩ (R2F)
2-77-1	200 kΩ (R1F)
2-78-1	300 kΩ (R3F, R4F)
2-79-1	1 MΩ (R2G)
2-80-1	2 MΩ (R1G)
2-81-1	3 MΩ (R3G, R4G)

SWITCHES-KNOBS

PART No.	DESCRIPTION
63-574	Rotary switch
100-855	Switch dial assembly
462-279	Knob
455-50	Knob bushing

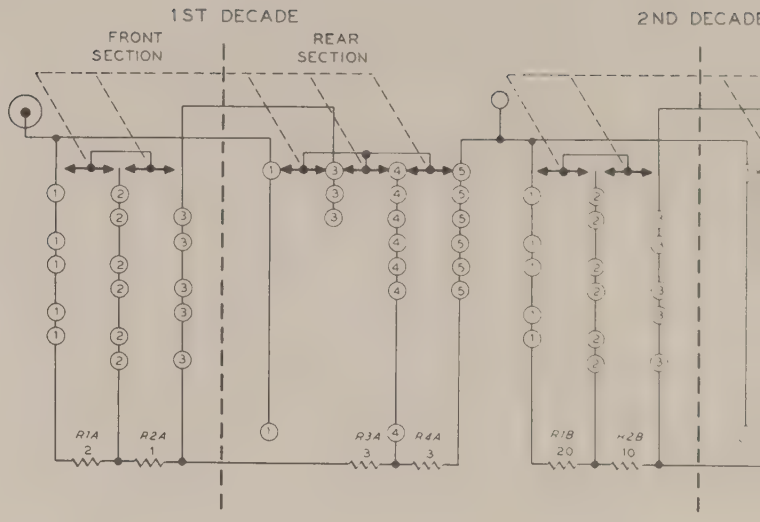
TERMINAL ASSEMBLY

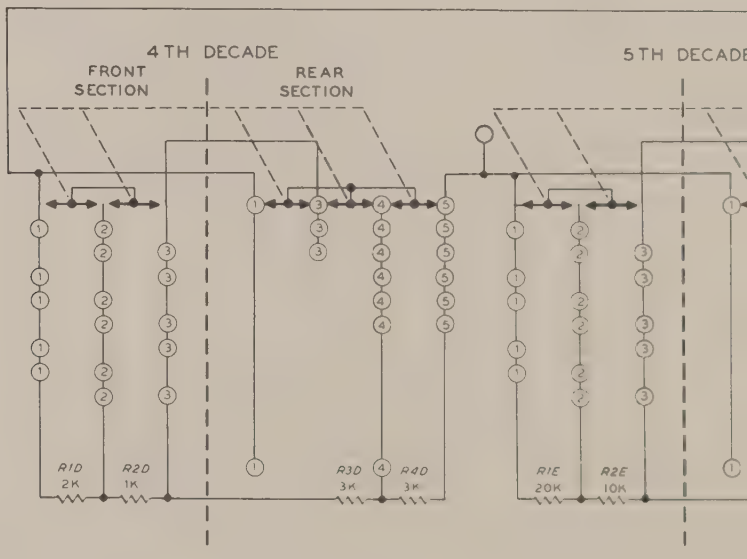
PART No.	DESCRIPTION
75-17	Binding post insulator
100-16-2	Binding post cap
427-5	Binding post base
436-22	Banana jack

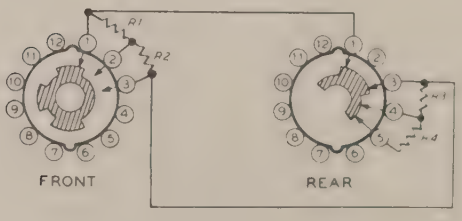
CHASSIS

PART No.	DESCRIPTION
90-437	Cabinet shell
100-862	Front panel
203-601	Subchassis

SWITCH POSITION	RESISTANCE
1	0X
2	1X
3	2X
4	3X
5	4X
6	5X
7	6X
8	7X
9	8X
10	9X
11	9X
12	3X







NOTES:

1. ALL RESI
2. ALL RESI
   X1 DECA
   DECADES
3. ALL SELE
4.
5. THIS
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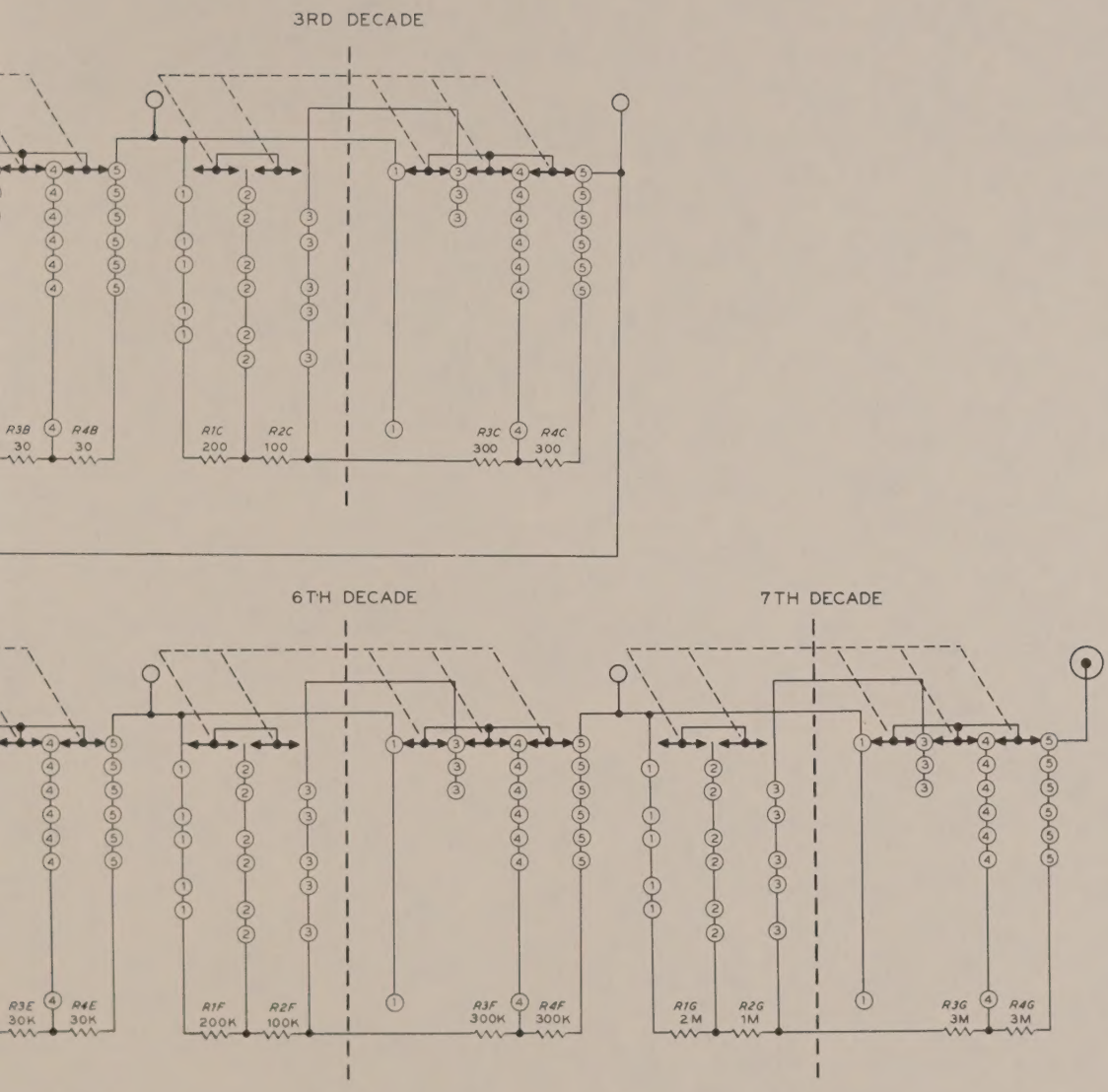
7. THIS



VALUES ARE IN OHMS (K=1000, M=1,000,000).

ARE 1 WATT PRECISION. THE RESISTORS IN THE
1.0%, AND THE RESISTORS IN THE REST OF THE
.1%.

SWITCHES SHOWN IN THE 0 POSITION.

THESE SYMBOLS INDICATE MOVABLE SWITCH WIPERS.

OL INDICATES FIXED SWITCH CONTACTS.

OL INDICATES A BINDING POST.

OL INDICATES A BANANA JACK.

SCHEMATIC OF THE

DECADE RESISTANCE BOX
MODEL EU-30A

SERVICE INFORMATION

The following Heath Company services are available if you need them: Replacement Parts, Technical Consultation, and Factory Service. Address all correspondence to:

HEATH COMPANY
Benton Harbor, Michigan 49022

For prompt service, use a separate letter for each department you write to.

Replacement parts and repair service are also available at your nearest Authorized Service Center or Heath Electronic Center. These Centers are listed in your Heath Catalog.

REPLACEMENT PARTS

If a replacement part is needed, please include the following information in your letter:

1. Part number and description.
2. Model Number and Series Number of the equipment.

If your equipment is in the Warranty period, add:

3. Date of purchase.
4. Nature of defect.

Heath Company will fill your order promptly. Please DO NOT RETURN PARTS unless they are requested. Parts that are damaged through carelessness or misuse by the customer will not be replaced without cost.

TECHNICAL CONSULTATION

You can write to our Technical Consultants for help with any Heath equipment, or for answers to any questions about the use of this equipment.

The completeness and accuracy of the advice mailed back to you depends entirely on the information in your letter. Be sure to include:

1. The Model Number and Series Number of the equipment (on blue and white identification label).
2. Date of purchase.
3. An exact description of the difficulty. Include switch positions, connections to other units, operating procedures, voltage reading, and any other information you think might be helpful.
4. List everything you have done in attempting to correct the difficulty.

FACTORY SERVICE

If you do not have qualified repair services at your disposal, you can return your equipment to the Heath Company Service Department to have it repaired for a minimum service fee. (Equipment that has been modified will not be accepted for repair.) Refer to Shipping Instructions for details on how to package and ship the equipment.

To be eligible for replacement parts under the terms of the Warranty, equipment returned for factory service must be accompanied by the invoice or the sales slip, or a copy of either. (If you send the original invoice or sales slip, it will be returned to you.)

SHIPPING INSTRUCTIONS

Check the equipment to see that all parts are in place. Then, wrap the equipment in heavy paper. Place the equipment in a strong carton, and put at least three inches of resilient packing material (shredded paper, excelsior, etc.) on all sides between the equipment and the carton.

Seal the carton with gummed paper tape and tie it with a strong cord. Ship it by prepaid Express or insured Parcel Post to:

HEATH COMPANY
Benton Harbor, Michigan 49022

Attach a letter, containing the following information to the outside of the carton:

1. Your name and return address.
2. Date of purchase.
3. A brief description of the difficulty.
4. Your authorization to ship the repaired unit back to you C.O.D. for the service and shipping charges, plus the cost of parts not covered by the Warranty.

WARRANTY

The Heath Company warrants that under conditions of normal use and service it will repair or replace any factory assembled unit whose performance does not meet published specifications and is returned to Heath prepaid within one year following date of shipment. The published specifications are those labelled "specifications" in the catalog and the manual for the unit. The replacement or repaired unit is shipped prepaid by us anywhere in the continental United States or to APO or FPO addresses. Shipments to other places are FOB factory. Heath's obligation is limited to such replacement or repair by Heath, and Heath is not responsible under this warranty or otherwise for any consequential damage or other loss in connection with the unit or its use.

Questions relating to repairs or warranty replacement in the continental United States (APO and FPO included) should be addressed to Heath Company, attention: Customer Relations, or the nearest Heathkit Electronic Center. In all other areas please contact the authorized Heathkit representative in your country, or Heath Company, attention: International Division.

HEATH COMPANY
Benton Harbor, Michigan 49022

The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

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